How the immune system learns about pathogens

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Humans mount rapid, potent, and specific immune responses against infecting pathogens. For example, in an acute infection, the immune system produces B cells and antibodies that bind and neutralize the pathogen; high-affinity B cells are stored as immune memory against subsequent infections by a similar pathogen. Successful immune responses depend on the system's ability to rapidly learn specific information on the pathogen; this information is encoded in the binding interfaces of the pathogen and the cognate receptors of B cells. Two key features of immune responses emerge from recent data and models: the non-equilibrium bio-molecular activation dynamics in acute infections, which involves novel proofreading mechanisms, and the complex architecture of the pre-existing the immune repertoire. We show how these features together enable the rapid production of information about the pathogen, generating potent and specific — i.e., low-entropy— responses.